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Abstract

A sanitary mass-disposal of nightsoil constitutes one of the major public health problems in the majority of Japanese cities and towns. Under the present economic situations in Japan, however, a low construction and operation cost and a simple disposal plant easy to operate are most essential to meet the prevailing needs, not to speak of complete destruction of pathogenic bacterial and parasitic organisms contained in the excreta to be disposed of.

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BIOLOGICAL AND CHEMICAL OBSERVATIONS ON MULTISEPTATE DIGESTION TANK DEVISED BY PROFESSOR YAMAGUTI

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A sanitary mass-disposal of nightsoil constitutes one of the major public health problems in the majority of Japanese cities and towns. Under the present economic situations in Japan, however, a low construction and operation cost and a simple disposal plant easy to operate are most essential to meet the prevailing needs, not to speak of complete destruction of pathogenic bacterial and parasitic organisms contained in the excreta to be disposed of.

Based on a principle of natural decomposition of excreata by fecal and aerial bacteria under anaerobic and aerobic conditions without use of artificial heating, Professor YAMAGUTI of our department devised tentatively a 52-chamber digestion tank, in which the fluid contents of one chamber are forced to another, as raw nightsoil is added to the first chamber, by flowing through the bottom passage of one partition and then over the top of the next partition, and so on alternately. The first example of this tank was constructed of concrete at Chayamachi near Okayama City, where the final effluent was diluted with water and drained directly into the tidal creek (Shioiri-gawa) discharging into Kozima Bay. (Fig. 1).

The observations made by the writer on some biological and chemical aspects of the digestion mechanism (Tables 1—4) suggest that about 20 chambers are sufficient for the purpose of digestion, because no further appreciable decomposition has been noted beyond the 20th chamber, and the offensive fecal odor has been eliminated short of this chamber, though a considerable amount of free ammonia still remains even in the final effluent. All the pathogenic organisms including the most resistant *Ascaris* eggs have been completely destroyed in the first chamber, probably as a result of ovicidal action of the fecal bacteria and their metabolic products.

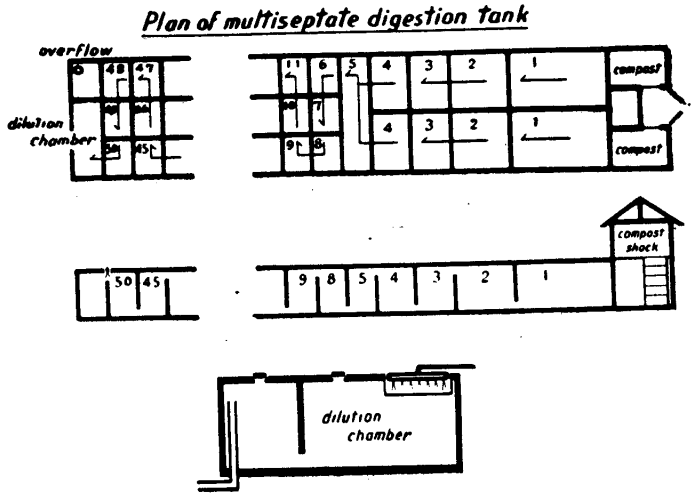

Fig. 1.

The thick layer of scum in the first chamber with its surface hardened in the air helps the fluid part of the contents decompose in a completely anaerobic condition. The surplus scum may be buried under the ground or used as material for compost, which is prepared in the compost shack attached to the end of the tank. The nightsoil thus treated can be harvested as harmless fertilizer from any of the chambers beyond the second, the fertilizing properties naturally decreasing from chamber to chamber.

The effluent of the 20th chamber, when drained into the above mentioned creek flowing at the rate of 70 cm. per second and diluted 4,000 to 10,000 times, is oxidized to such an extent that nitrous N appears in a dilution of 1 : 100 and nitric N appears in a dilution of 1 : 1000 or more. The water of the creek 50 meters below the draining point shows no difference from that above the same point so far as the free ammonia contents, pH and the length of time required for decoloration of methylene blue are concerned. This fact clearly indicates that the effluent from the 20th chamber can be drained into the drainage creek without essentially polluting the latter.

Table 1

Chamber No.	2	5	10	20	30	40	49	52	creek
Temperature C		25.5	26.0	26.5	26.5	27.0	27.0	27.0	29.0
Color		greenish brown	greenish brown	brown	brown	brown	brown	light brown	light white
Turbidity		+	+	+	+	+	+	+	−
Odor		fecal	fecal	putrid	putrid	putrid	putrid	putrid	odorless
pH		8.2	8.4	8.4	8.6	8.6	8.6	8.6	7.0
Ammoniac N. ppm		3973.5	3944.4	3863.1	4489.6	2714.7	3393.4	2036.0	6.2
Albuminoid ammoniac N. ppm		208.8	345.0	221.8	197.2	260.9	216.7	156.4	
Nitric N.		−	−	−	−	−	−	−	+
Nitrous N.		−	−	−	−	−	−	−	+
Length of time required for decoloration of methylenblue		1 minute	1	1	1	1	1	1	above 5 hours
Residue after evaporation ppm		18500	19900	17400	17900	19700	19100	10200	10600
B O D ppm		12393	12477	12912	5021	7808	5518	3240	132
Population of fecal bacteria billion/cc		2.5	2.1	1.9	1.6	1.6	2.0	110	0.026
Population of Escherichia group thousand/cc		3800	310	90	95	75	22	190	7.2
Bacilli		+	+	+	+	+	+	+	
Cocci		+	+	+	+	+	+	+	
Spirilli		+	+	+	+	+	+	+	
Infusoria		+	+	+	+	+	+	+	+
Viability of ova		dead	dead						

July 4, 1955 Cloudy Temperature 30°C

Table 2

Chamber No.	2	5	10	20	30	40	49	52	creek
Temperature C	21.5	21.0	23.0	23.0	22.0	23.0	20.5	20.5	20.5
Color	greenish brown	deep brown	deep brown	brown	brown	brown	brown	light yellow	milky white
Turbidity	+	+	+	+	+	+	+	+	+
Odor	fecal	fecal	putrid	putrid	putrid	putrid	putrid	putrid	slight
pH	7.52	8.05	8.20	8.22	8.20	8.25	8.35	8.30	7.50
Ammoniac N. ppm	4171.2	3905.0	4037.5	4437.5	3860.6	3283.7	3638.7	1354.4	5.3
Albuminoid ammoniac N. ppm	399.3	310.5	221.8	133.0	266.2	194.4	133.0	44.3	
Nitric N.	−	−	−	−	−	−	−	−	+
Nitrous N.	−	−	−	−	−	−	−	−	+
Length of time required for decoloration of methylenblue	1 minute	1	1	1	1	1	1	5	above 5 hours
Residue after evaporation ppm	21560	17050	19100	19680	21020	16280	12100	6100	1200
B O D ppm	9100	5575	3690	6025	5490	3955	3390	2410	18
Population of fecal bacteria billion/cc	0.25	0.75	1.4	0.6	0.5	1.5	0.55	0.6	0.004
Population of Escherichia group thousand/cc	1000	55		60	100		50	50	230
Bacilli	+	+	+	+	+	+	+	+	
Cocci	+	+	+	+	+	+	+	+	
Spirilli	+	+	+	+	+	+	+	+	
Infusoria					+	+		+	+
Viability of ova	dead	dead							

October 9, 1955 fine, Temperature 21.5°C

Table 3

Chamber No.	2	5	10	20	30	40	49	52	creek
Temperature C	8.0	8.0	8.0	8.5	8.5	8.0	8.0	8.5	8.5
Color	yellowish brown	yellowish brown	yellowish brown	yellowish brown	yellowish brown	yellowish brown	yellowish brown	yellowish brown	colorless
Turbidity	+	+	+	+	+	+	+	+	+
Odor	fecal	fecal	putrid	putrid	putrid	putrid	putrid	putrid	odorless
pH	7.90	7.95	8.20	8.25	8.25	8.40	8.50	8.35	7.20
Ammoniac N. ppm	3905.0	3638.7	3905.0	3550.0	3283.7	3061.9	3505.6	798.8	2.3
Albuminoid ammoniac N. ppm	266.2	177.5	221.8	179.5	88.7	44.3	133.0	22.1	
Nitric N.	−	−	−	−	−	−	−	−	+
Nitrous N.	−	−	−	−	−	−	−	−	+
Length of time required for decoloration of methylenblue	1 minute	1	1	1	1	1	1	3 hours	above 5 hours
Residue after evaporation ppm	39200	32100	33200	29000	27200	25400	21800	3500	7800
B O D ppm	5820	5525	5265	3800	5025	3300	2512	1950	12
Population of fecal bacteria billion/cc	39	17	36	21	12	2.1	4.2	0.8	0.29
Population of Escherichia group thousand/cc	55000	800	2900	140	180	20	520	80	400
Bacilli	+	+	+	+	+	+	+	+	
Cocci	+	+	+	+	+	+	+	+	
Spirilli	+	+			+		+	+	
Infusoria						+		+	+
Viability of ova	dead								

January 17, 1956 fine, Temperature 12°C

Table 4

Chamber No.	2	5	10	20	30	40	49	52	creek
Temperature C	17.0	16.5	16.5	17.0	17.0	17.0	17.0	18.0	22.0
Color	greenish brown	greenish brown	greenish brown	light greenish brown	brown	brown	brown	light brown	milky white
Turbidity	+	+	+	+	+	+	+	+	+
Odor	fecal	fecal	fecal	putrid	putrid	putrid	putrid	light putrid	slight
pH	8.32	8.45	8.39	8.35	8.35	8.32	8.59	8.14	7.70
Ammoniac N. ppm	3638.7	3372.5	2840.0	3106.2	2706.8	2751.1	2504.9	1665.0	5.6
Albuminoid ammoniac N. ppm	355.0	399.3	310.5	266.2	266.2	232.2	133.0	67.0	
Nitric N.	−	−	−	−	−	−	−	−	+
Nitrous N.	−	−	−	−	−	−	−	−	+
Length of time required for decoloration of methylenblue	1 minute	1	1	1	1	1	1	30	above 5 hours
Residue after evaporation ppm	35100	23100	21500	18100	17400	15300	13000	8000	9100
B O D ppm	6262	4612	4820	3321	3615	1606	2208	602	46
Population of fecal bacteria billion/cc	0.8	1.3	16	19	1.0	1.5	2.0	30	0.06
Population of Escherichia group thousand/cc	1300	6800	4300	1800	1700	1000	650	110	70
Bacilli	+	+	+	+	+	+	+	+	
Cocci	+	+	+	+	+	+	+	+	
Spirilli	+	+	+	+	+	+	+	+	
Infusoria		+	+	+	+	+	+	+	+
Viability of ova	dead	dead							

April 16, 1956 fine, Temperature 24°C